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Session 5

Tensor analyzing powers for ^{7}Li induced transfer breakup reactions

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Outline

- Importance
- Reactions studied
- Experiment
- Data
- Calculations
- Conclusions

Importance

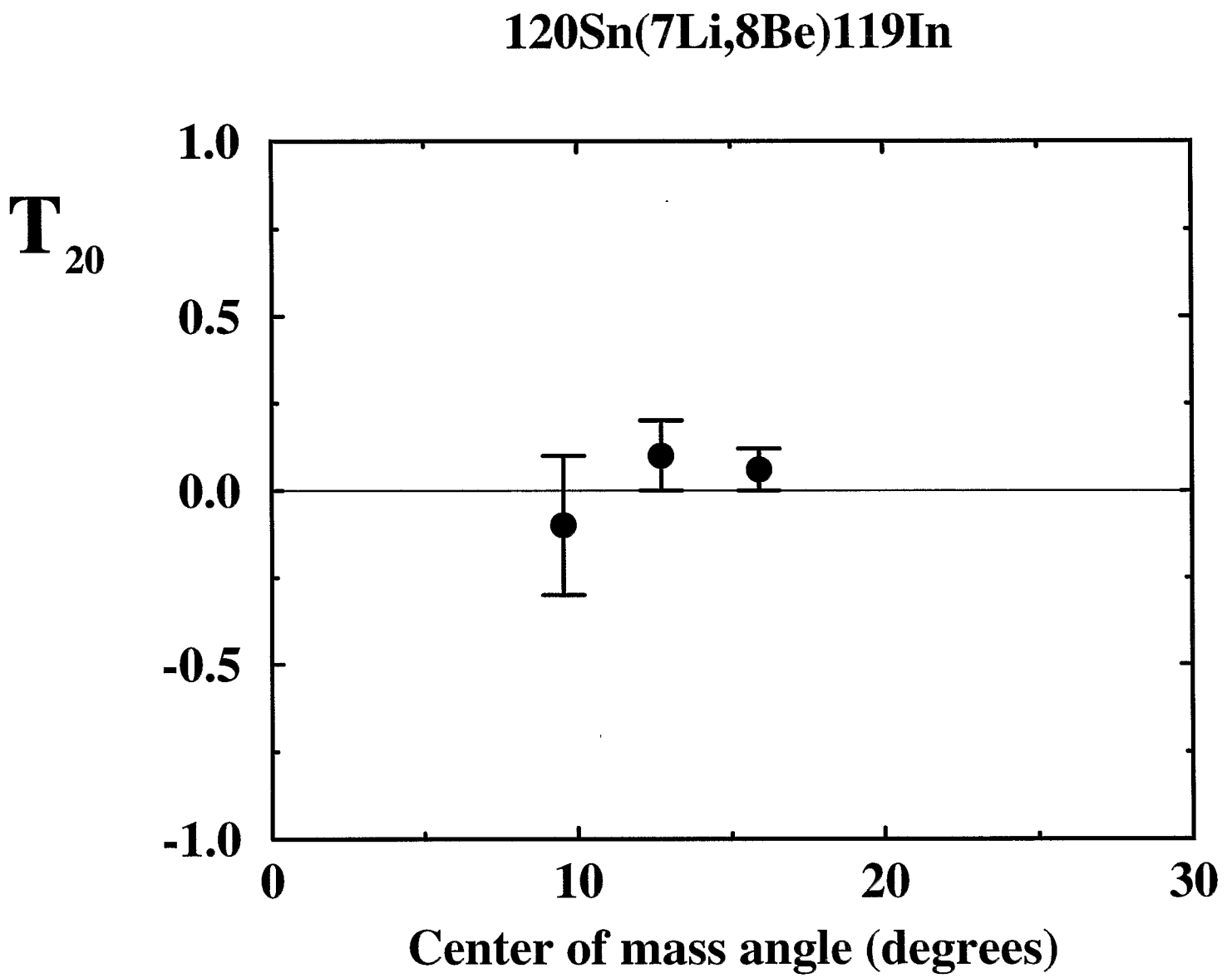
- Transfer breakup combines two processes which are relatively well understood in isolation.
- Relatively little published on transfer breakup reactions.
- ^{7}Li induced reactions relevant to studies of stable nuclei with similar cluster structures.
- Relevant to studies with radioactive beams having large transfer and fragmentation cross-sections.
- Challenge: test thoroughly CC and CDCC calculations with complex transfer breakup reactions.

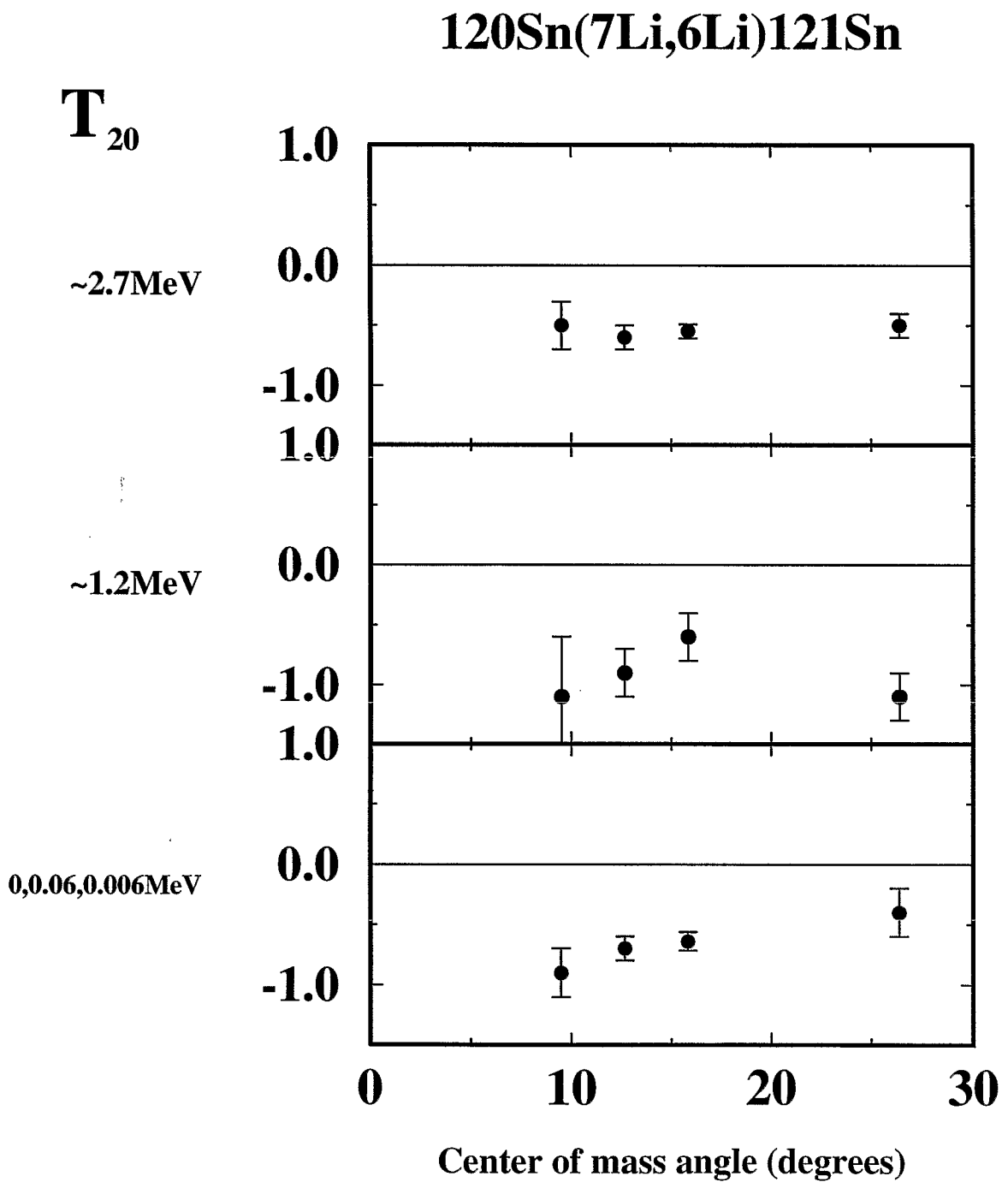
Reactions studied

- $^{120}Sn(^{7}Li,^{8}Be_{gs} \rightarrow 2\alpha)^{119}In$ populating the unresolved ground ($9/2^{+}$) and 0.31MeV ($1/2^{-}$) states of ^{119}In.
- $^{120}Sn(^{7}Li,^{6}Li^{*} \rightarrow \alpha + d)^{121}Sn$ from the 2.19MeV (3^{+}) state in ^{6}Li populating the unresolved ground ($3/2^{+}$), 0.006MeV ($11/2^{-}$) and 0.06MeV ($1/2^{+}$) states in ^{121}Sn. Data also obtained for peaks at ~1.2MeV (9 states from 0.87 - 1.43MeV) and ~2.7MeV (6 states from 2.66 - 2.74MeV).
- 70MeV polarized ^{7}Li beam.
- T_{20} measured.

Experiment

- Two pairs of triple telescopes (230μm Si surface barrier ΔE, 4mm SiLi E, 4mm SiLi veto detectors).
- Positioned symmetrically about the beam axis, one above and one below the reaction plane (allowing good angular resolution of intermediate ^{8}Be and ^{6}Li* prior to breakup).
- Clean data due to coincidence requirements and fragment energy determination and particle identification.


120Sn(7Li,8Be)119In
T20
1.0
0.5
0.0
-0.5
-1.0
0
10
20
30
Center of mass angle (degrees)

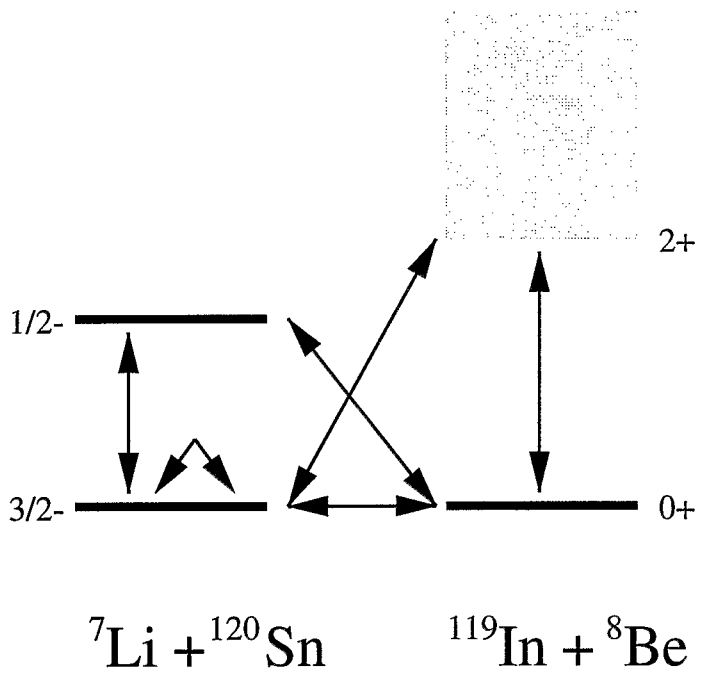

120Sn(7Li,6Li)121Sn
T20
1.0
0.0
-1.0
~2.7MeV
1.0
0.0
-1.0
~1.2MeV
1.0
0.0
-1.0
0,0.06,0.006MeV
0
10
20
30
Center of mass angle (degrees)

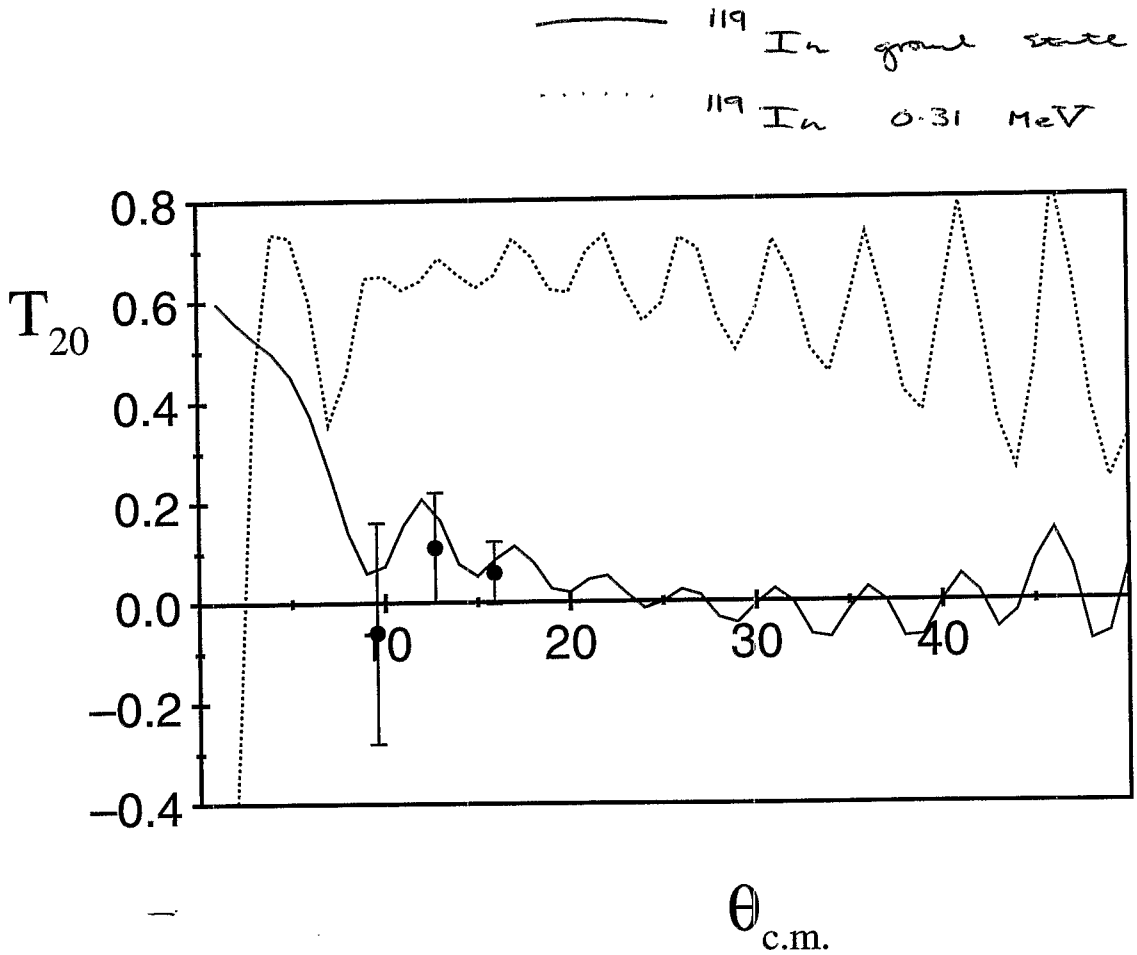
Calculations

- Code FRESCO.
- Coupled channels for the reaction $^{120}Sn(^{7}Li,^{8}Be \rightarrow 2\alpha)^{119}In$.
- Continuum-discretized coupled channels for $^{120}Sn(^{7}Li,^{6}Li^{*} \rightarrow \alpha + d)^{121}Sn$.

$^{120}Sn(^{7}Li,^{8}Be \rightarrow 2\alpha)^{119}In$

- One proton pickup reaction.
- L = 0 breakup.
- Isotropic distribution of alpha fragments in ^{8}Be c.m. frame.
- Entrance optical potentials from literature.
- Exit optical potentials from single folding method using empirical α + ^{120}Sn optical model potential from literature and $^{8}Be = \alpha + \alpha$ cluster wavefunctions.
- Gaussian-shaped binding potential for $^{8}Be = \alpha + \alpha$.
- ^{8}Be ground state assumed to be weakly bound and potential adjusted to reproduce this.
- ^{8}Be spectroscopic amplitudes from Cohen and Kurath.
- Coupling diagram.


2+
1/2-
3/2-
0+
$^{7}Li + ^{120}Sn$
$^{119}In + ^{8}Be$


119 In ground state
119 In 0.31 MeV
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
T20
10
20
30
40
θc.m.

$^{120}Sn(^{7}Li,^{6}Li^{*} \rightarrow \alpha + d)^{121}Sn$

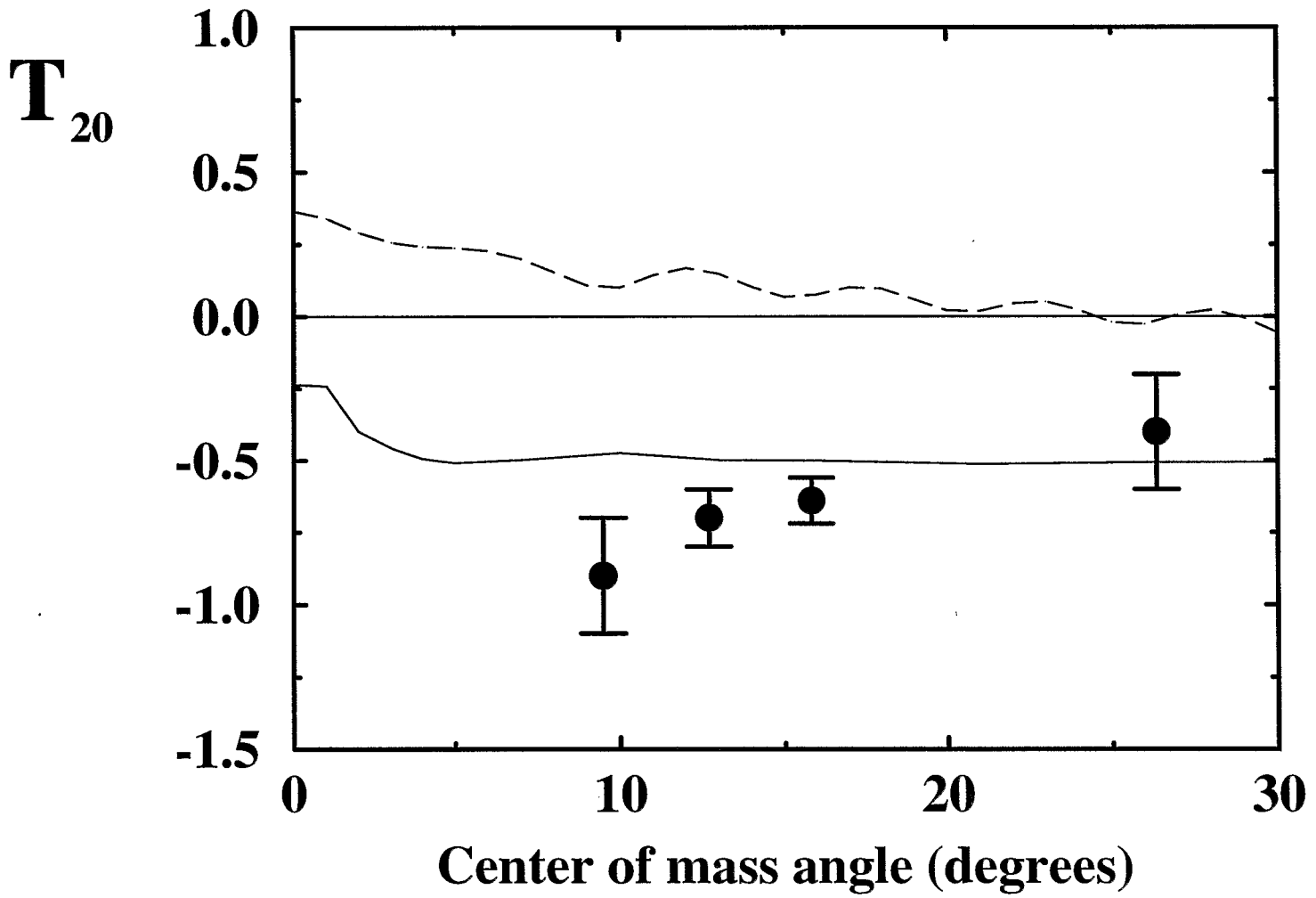
- One neutron stripping reaction.
- L = 2 breakup in ^{6}Li c.m. (L = 4 negligible due to α + d L = 2 cluster structure of state in ^{6}Li).
- Anisotropic fragment distribution.
- Need to correct for position of detectors. Technique developed for this correction.

Correction technique

- CDCC calculations generate m-substate populations for L = 2 breakup.
- m-substate populations incorporated in Monte Carlo calculations for reactions.
- Monte Carlo calculations generate two-dimensional spectrum of θ,ϕ spherical polar coordinates in the helicity frame for relative momentum of fragments in ^{6}Li c.m.
- Resulting probability function used to provide detector phase space correction which is applied to results of CDCC calculations.

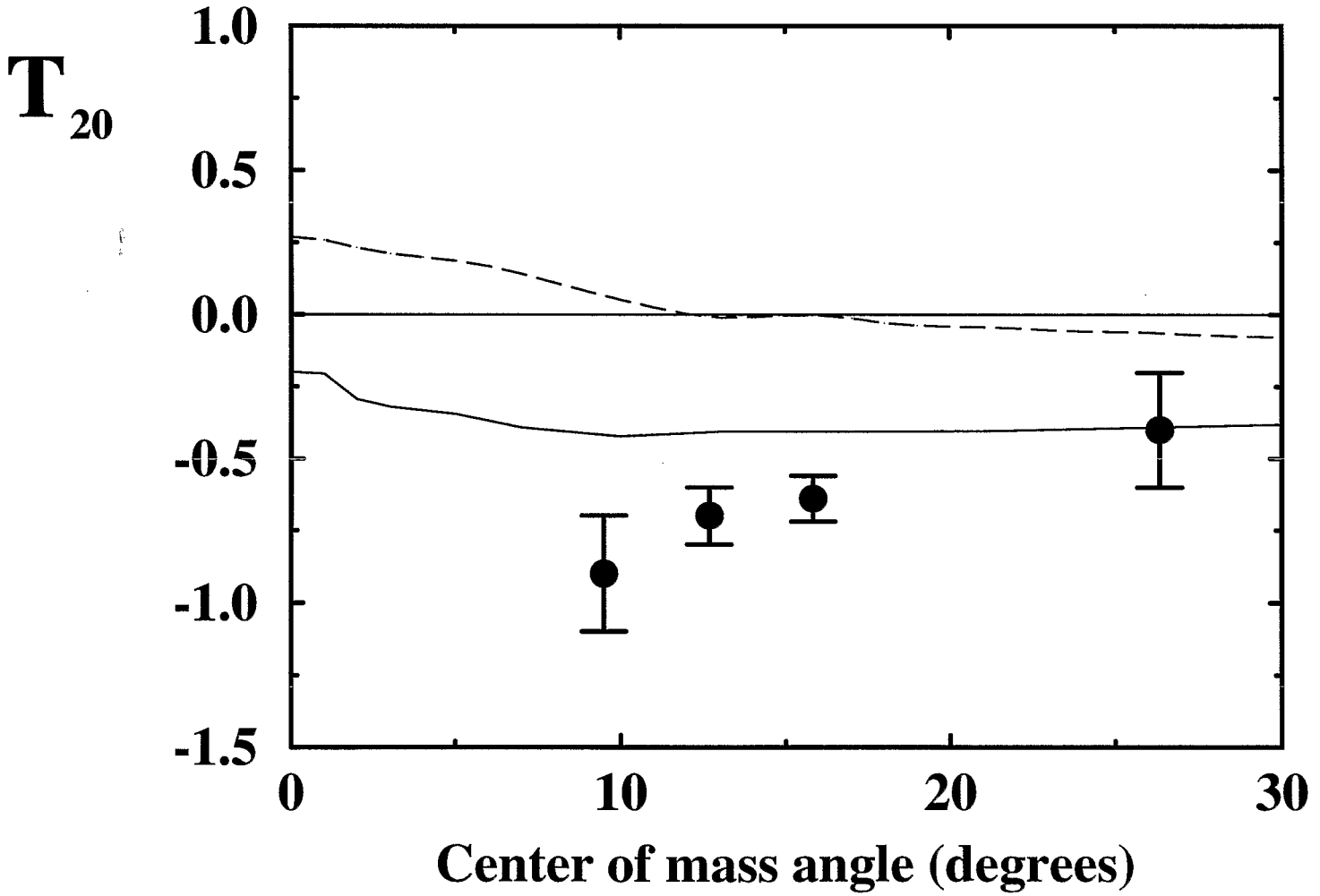
$^{120}Sn(^{7}Li, ^{6}Li)^{121}Sn$

0 MeV 3/2+



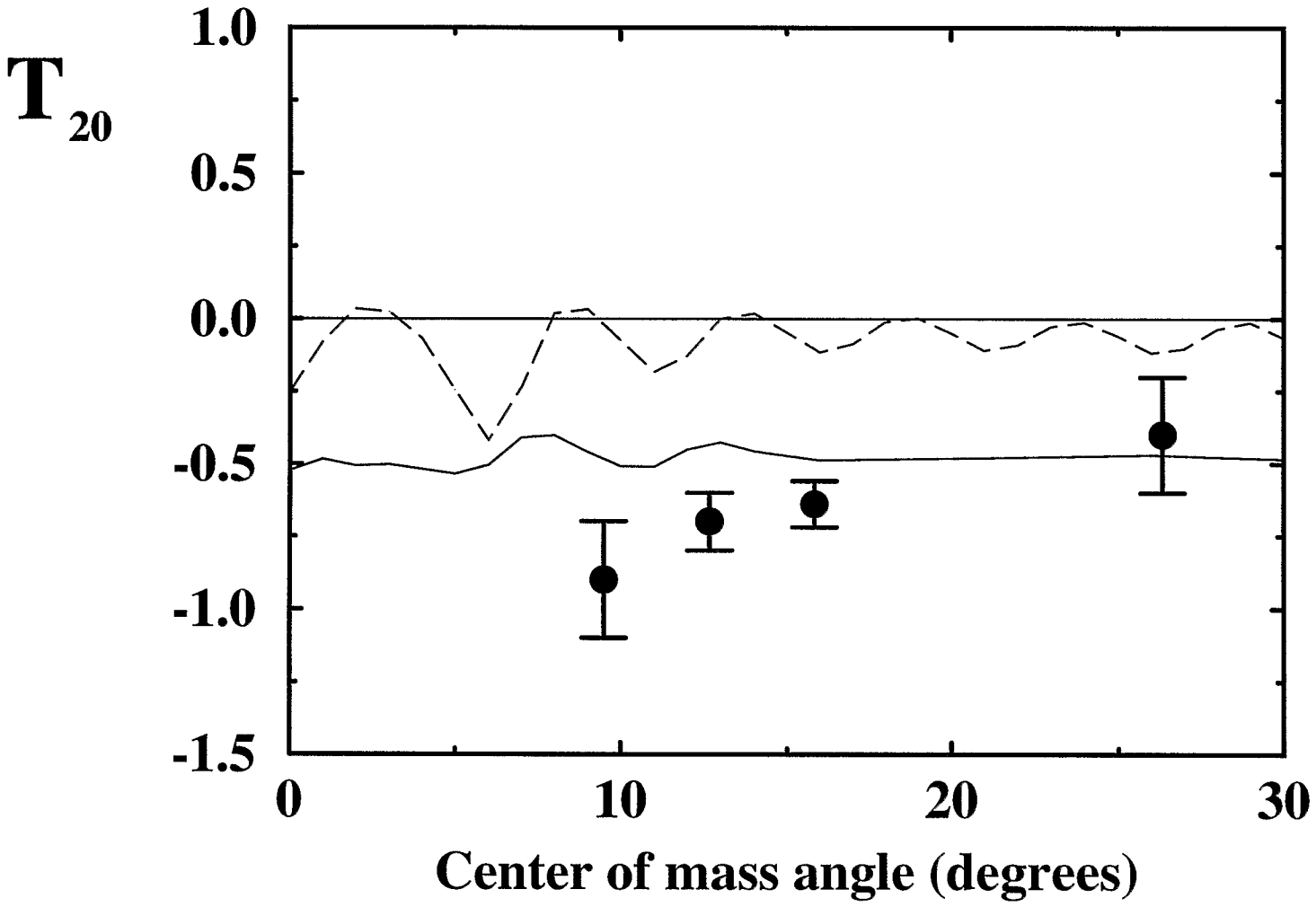
$^{120}Sn(^{7}Li, ^{6}Li)^{121}Sn$

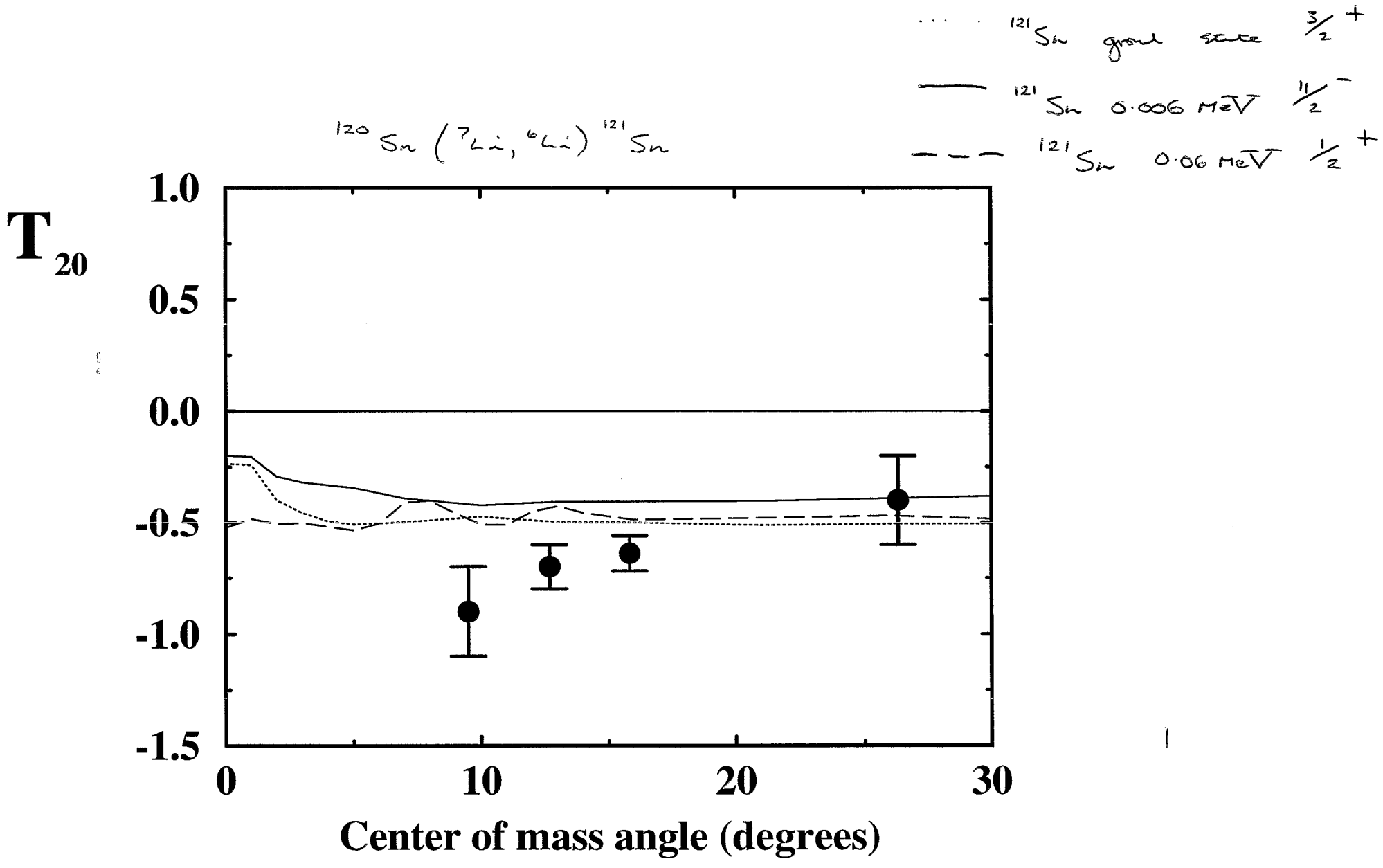
0.006 MeV 11/2-



$^{120}Sn(^{7}Li, ^{6}Li)^{121}Sn$

0.06 MeV 1/2+




^{121}Sn ground state 3/2 +
^{121}Sn 0.006 MeV 11/2 −
^{121}Sn 0.06 MeV 1/2 +
^{120}Sn (^{7}Li, ^{6}Li) ^{121}Sn
T20
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
10
20
30
Center of mass angle (degrees)

Conclusions

- Measured T_{20} for one nucleon transfer breakup reactions.
- Performed CC and CDCC calculations.
- Developed technique for detector phase space corrections for anisotropic breakup.
- $^{120}Sn(^{7}Li,^{8}Be \rightarrow 2\alpha)^{119}In$ found to populate ^{119}~~Sn~~ In ground state.
- $^{120}Sn(^{7}Li,^{6}Li^{*} \rightarrow \alpha + d)^{121}Sn$ analysis inconclusive.

Collaboration

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